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Numerical study of conjugated cooling by forced convection-conduction of 3D heaters

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ABSTRACT

Recent advances in modern electronics have resulted in miniaturization, a greater number of functionalities, and an increase in the speed of electronic devices, such as smartphones, notebooks, tablets, and computers, resulting in a significant increase in power density. If thermal control is not effective, excessive heat generation can result in high operating temperatures, compromising the safety and reliability of these devices. In this context, in the present work a numerical study of an invariant descriptor of the conjugate process of heat transfer by forced convection-conduction of discrete heaters in channels was carried out, by obtaining the conjugate influence coefficients g+, grouped in a conjugate matrix G+. With this descriptor, the temperature of each protruding 3D heater mounted on a conductive substrate of a horizontal rectangular channel can be predicted from the knowledge of arbitrary heat dissipation rates in the heaters. In the simulations, the governing equations were solved numerically within a single domain encompassing the solid and fluid regions, by a coupled procedure, using the Control Volumes Method through the commercial software ANSYS/ FluentTM 19.2. To obtain the results, typical values of geometries and thermophysical properties found in cooling applications of electrical and electronic components mounted on a printed circuit board were used. Some examples have been illustrated, indicating the effects on the conjugated coefficients of influence, the thermal conductivity of the substrate and the Reynolds number of the fluid flow in the channel. A comparison with experimental results was performed and showed an excellent agreement.

Keywords: Descriptor Invariant, Conjugate Heat Transfer, Numerical analysis.

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